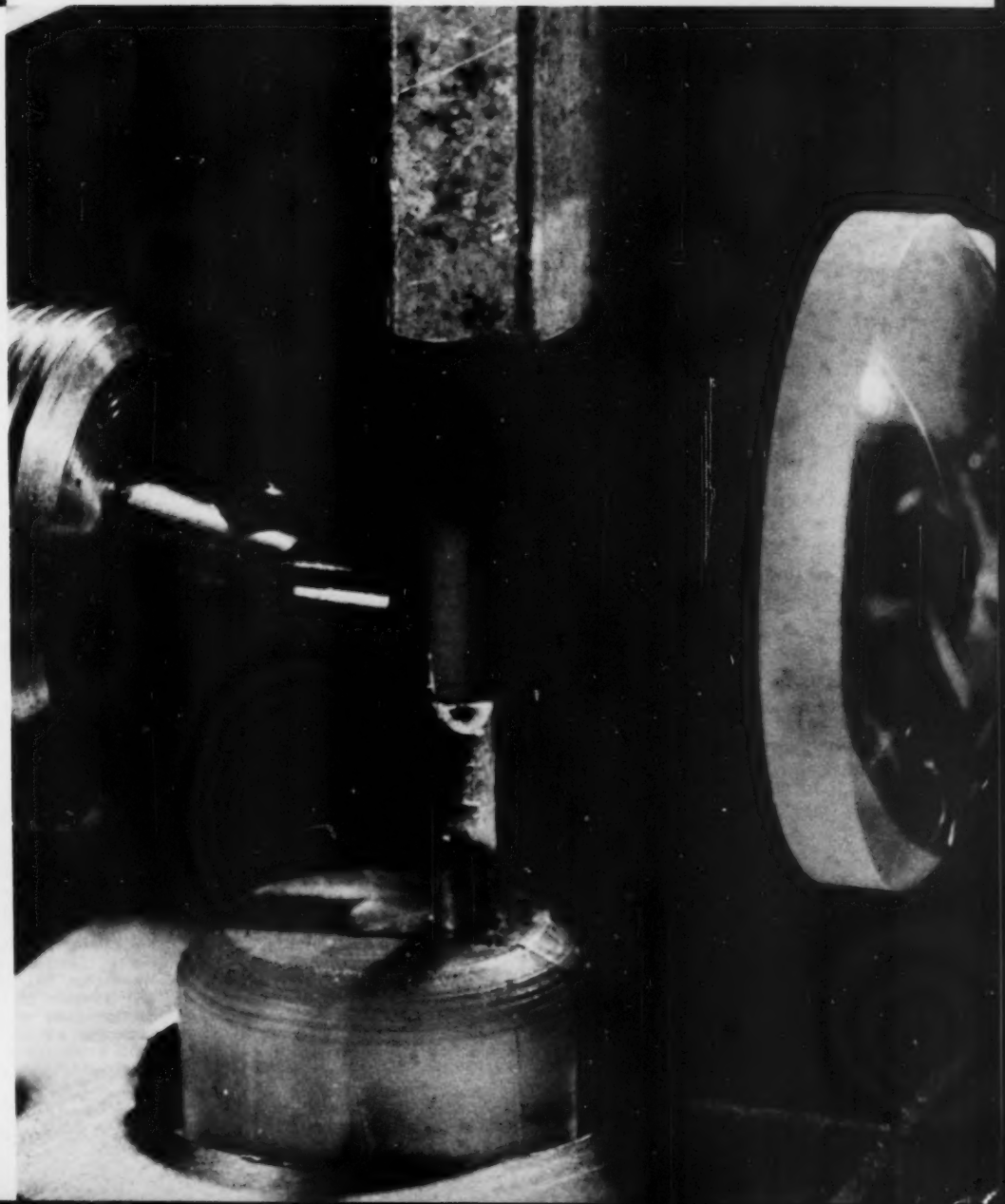
April 1972

A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

U.S. NATIONAL BUREAU OF STANDARDS

Technical News Bulletin



UNITED STATES DEPARTMENT OF COMMERCE

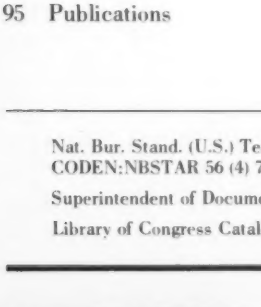
NATIONAL BUREAU OF STANDARDS
Technical News Bulletin
APRIL 1972 / VOL. 56, NO. 4 / ISSUED MONTHLY

CONTENTS

Nat. Bur. Stand. (U.S.) Tech. News Bull.
CODEN:NBSTAR 56 (4) 73–96 (1972)

Superintendent of Documents Catalog No. C13.13:56/4

Library of Congress Catalog No. 25–265227



Cover: Diode used to make the world's highest frequency measurement. The quartz lens (right) is used to focus 3.39 μm He-Ne laser radiation and the waveguide (top) transmits 49 GHz radiation. Radiation from a CO_2 laser is also focused on the diode. See page 75.

U.S. DEPARTMENT OF COMMERCE
Peter G. Peterson, Secretary

James H. Wakelin, Jr.
Assistant Secretary
for Science and Technology

NATIONAL BUREAU OF STANDARDS
L. M. Branscomb, Director

Prepared by the NBS Office of Technical Information and Publications, Washington, D.C. 20234

W. R. Tilley, Chief

Managing Editor
D. V. Baker

Contributing Editors
L. K. Armstrong, R. T. Cook, D. K. Coyle, J. E. Kluge, C. R. Naas, A. Schach, C. N. Smith, S. A. Washburn, D. E. Webb

C. Messina, Visual Editor

The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

The Institute for Basic Standards

The Institute for Materials Research

The Institute for Applied Technology

Center for Radiation Research

Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription: Domestic, $3; foreign, $4; single copy, 30 cents. Use of funds for printing this publication approved by the Director of the Office of Management and Budget (June 22, 1971).

Dr. K. M. Evenson, with part of the apparatus used in measuring the frequency of an infrared helium-neon laser.

BREAKTHROUGH
IN MEASUREMENT SCIENCE

A new era in measurement science was inaugurated recently by scientists at the Bureau's Boulder laboratories, when they achieved the highest frequency measurement ever made.[1] By measuring the frequency of an infrared laser whose wavelength was already known, the team of scientists laid the groundwork for linking the international standards of length and time.

The importance of this linking was described by Dr. Lewis M. Branscomb, Director of NBS, in his announcement of the breakthrough. "Ever since Albert Einstein showed that time can be considered the fourth dimension of the space in which we live," Dr. Branscomb said, "scientists have looked forward to the possibility of using one gage—one 'yardstick' so to speak—not only for the three dimensions of space but for the fourth dimension of time as well. To interchange clocks and rulers scientists must know the speed with which light travels which is equal to its wavelength times its frequency. With this demonstration that both the space (wavelength) and time (frequency) dimensions of a single light source can be measured with prodigious accuracy, this goal is now within our grasp."

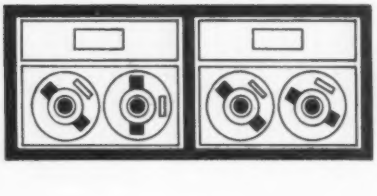
"A 30-fold more accurate determination of the speed of light should be possible," Dr. Branscomb said, "suggesting that this universal constant of nature might some day be assigned an arbitrary number, with only one standard used for both length and time measurement."

In the meantime, a more accurate value for the speed of light will be of great value not only to the space scientist in tracking satellites and space vehicles and the astronomer in measuring interplanetary distances, but to all physicists who must use this constant of nature in many of their calculations.

"Many other groups will benefit directly from this breakthrough," Dr. Branscomb continued, "and all of us will benefit indirectly. Manufacturers should achieve finer accuracy in instrument manufacture and other precision equipment. Environmental scientists will find that improved control of precisely tuned lasers will permit new progress in the study of minute quantities of pollutants."

The experiment found the absolute frequency of the helium-neon laser to be 88,376,245 million hertz (cycles per second), only a factor of 5 lower in frequency than visible light. This highest frequency measurement yet made by man represents a hundredfold increase in the span of frequency measurements over the last 4 years and surpasses the recent record achievement of a team of MIT scientists. Prior to this measurement, frequencies this high had to be calculated by dividing the speed of light by the

continued on page 89



CCST NEWS

The NBS Center for Computer Sciences and Technology, under P.L. 89–306, is the Federal scientific and technical focal point for insuring that computer services meet the needs of the customer. Significant activities of the Center are reported in this column for the information of interested computer customers.

CALENDAR DATE STANDARDS APPROVED BY ANSI

A voluntary national standard has been approved by the American National Standards Institute for representing calendar dates in computer systems. This standard will improve data processing operations and facilitate information interchange. The standard, identified as ANSI X3.30-1970, stipulates that dates are to be represented by first the year, followed by the month and the day of the month. For example, July 1, 1972, will be represented as 19720701 in computer files. The high order (leftmost) digits of the year may be omitted in applications not requiring a four-digit year. On computer printouts and on readable inputs the data elements can be separated by hyphens: 1972-07-01.

This method of representing dates was adopted as a Federal Information Processing Standard (FIPS PUB 4) by the Office of Management and Budget in 1968, and its use is required in Government computer usage. In 1970 the International Organization for Standardization also adopted this method of writing dates in its Recommendation 2014.

These standards also provide rules for representing ordinal dates where the days of the year are numbered 001 through 365 (366 in leap years). In using this technique, July 1, 1972, is represented as 1972183. On user-readable listings a hyphen may be used as a separator; i.e., 1972-183.

Information concerning these standards can be obtained from the Office of Information Processing Standards, Center for Computer Sciences and Technology, National Bureau of Standards, Washington, D.C. 20234, telephone (301) 921-3551.

FEDERAL COBOL STANDARD ESTABLISHED

On January 28, 1972, the Director of the Office of Management and Budget approved the establishment of a Federal COBOL (*Co*mmon *B*usiness *O*riented *L*anguage) standard based on the American National Standard (ANS) COBOL X3.23-1968. ANS COBOL defines the elements of the COBOL programming language and the rules for their use. The standard is used by software suppliers as the reference authority in developing compilers and by users in writing COBOL programs. A primary reason for using the standard is to provide great interchangeability of programs among a wide variety of ADP installations. The Federal Standard COBOL is contained in Federal Information Processing Standard Publication 21 (FIPS PUB 21).

The basic objectives of the Federal Standard COBOL are to achieve the recognized advantages of using higher level languages and to protect program investments by making it easier and less expensive to exchange programs between different computer systems, including replacement systems.

The Federal Standard COBOL is applicable to and will be used in programming business-oriented computer applications; i.e., those applications that emphasize the manipulation of characters, files, and input/output data, as contrasted with those concerned primarily with the computation of numeric values that are developed or acquired for Government use. Special attention has been given to insure that programs for business-oriented applications that will or are likely to be used by organizations outside the Federal Government (e.g., State and local governments and others) are written in Federal Standard COBOL for maximum interchangeability in their use.

The technical specifications of Federal Standard COBOL are consistent with the Functional Processing Modules (FPM's) specified by the American National Standard. The Federal Standard, however, consists of four specific combinations of these modules, known as Low, Low-Intermediate, High-Intermediate and High Level Federal Standard COBOL. Each level is defined as consisting of the high or low level nucleus and selected levels of six of the seven FPM's of the ANS COBOL as shown in the table.

Implementation of the Federal Standard COBOL calls for all compilers added to the Federal software inventory after July 1, 1972, to be identified as conforming to one of the levels of the Federal Standard. Each compiler must include all of the language elements of the level specified, except that a compiler acquired exclusively to produce object programs for computers without random access devices need not include the random access module, regardless of level.

A compiler being acquired by a Government agency may include language elements over and above the requested level, (whether or not they are a part of the Federal COBOL Standard) but such added language elements will not be specified for development or acquisition unless an internal agency waiver is first obtained. Waivers authorizing such compilers must stipulate that the additional elements, when used, will be automatically identified and flagged (annotated) in the source program documentation compiling system (i.e., compiler or preprocessor).

The waiver procedure is not intended for the procurement of a High-Intermediate level compiler to satisfy a Low-Intermediate level requirement when the latter is not available. However, it is required in these situations that the High-Intermediate compiler flag the High-Intermediate elements used. The Federal Standard intends that programs written in standard COBOL should, as far as practicable, be limited to the elements of one of the specified levels. Although the use of flagged unilateral extensions—unique language elements added to Federal COBOL by software suppliers—in applications programs is permitted, the use of such extensions will impede interchangeability of programs and may complicate future conversion to replacement computers. Extensions are expected to be employed, therefore, only when their use will result in efficiencies that clearly outweigh the difficulties that they may later cause.

Agencies are permitted to waive the requirements of the Federal Standard COBOL regarding its use and compliance with the compiler specifications upon proper internal justification. They are required to report waiver actions to NBS so that appropriate recognition can be given these actions in planning future revisions to the Federal Standard COBOL.

Compliance with the Federal Standard COBOL levels is currently a responsibility of the agencies acquiring a COBOL compiler. A centralized validation service will be available in fiscal year 1973 to assist agencies in the area of COBOL compilers. NBS is developing the criteria for measuring the compliance of COBOL compilers with the Federal Standard and will monitor the Government-wide validation service.

Detailed information concerning the adoption of COBOL as a Federal Information Processing Standard is contained in FIPS PUB 21. Copies can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 at a cost of 20 cents (SD Catalog Number C13.52:32).

Functional Processing Modules (FPM) of Federal Standard COBOL Levels

	Low Level	*Low-Intermediate Level*	*High-Intermediate Level*	*High Level*
Nucleus	Low (1)	High (2)	High (2)	High (2)
FPM				
Table handling	Low (3)	Intermediate (4)	Intermediate (4)	High (5)
Sequential access	Low (6)	High (7)	High (7)	High (7)
Random access	–	High (9)	High (9)	High (9)
Sort	–	–	Low (10)	High (11)
Segmentation	–	Low (14)	Low 3⁄614½	High 3⁄615½
Library	–	Low (16)	Low (16)	High (17)

The numbers in parentheses refer to chapters in ANS-COBOL X3.23-1968. A dash indicates that the corresponding ANS FPM is omitted.

WORKSHOP ON DISPLAY TERMINALS AND WIRED CITIES

The "wired" business office, factory, and home—connected by a two-way communications network—are now realities and people of many occupations using computers via such networks is now a common part of American industrial life. Future networks will reach directly into the home, using much of the $23 billion investment that the U.S. consumer has already made in his personal "display terminal," his television set. Equipment available already permits interaction between the home TV set and other communications or computer systems. Interactive response, common in human communication (audible and visual), is now extended to communication between man and the computer.

For the purpose of exploring the state of this art, a 2-day "Workshop on Display Terminals and Wired Cities" was held at NBS on November 30 and December 1, 1971. This Workshop was jointly sponsored by the Society for Information Display, the National Cable Television Association, and the National Bureau of Standards, with participation by the Communications Technology Group of the Institute of Electrical and Electronics Engineers. It considered the problems of display terminal equipments; their interfaces, programming, operating protocol

continued on page 94

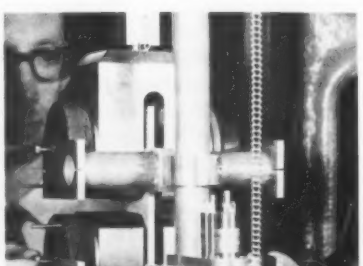
MEASURING MECHANICAL COMPLIANCE OF METAL SPECIMENS

EXTENSOMETER USES LINEAR VARIABLE-DIFFERENTIAL TRANSFORMERS

Tension compliance measurements on notched metal specimens made at NBS have verified previously computed values for compliance.[1] For these measurements, M. J. Orloski modified an extensometer, employing two linear variable-differential transformers, that had been developed in pilot model form by J. R. Houghton. The precision and resolution of the apparatus used in this work adds confidence to mechanical compliance calibrations, one goal of the National Aeronautics and Space Administration in supporting the program.

MEASURING FRACTURE TOUGHNESS

Fracture toughness, an important characteristic of metals used in many structural applications, is determined from measurements of the dimensions of specimens, applied load, and mechanical compliance. A variety of specimens is used in obtaining data for rating the resistance of materials to failure in a brittle manner. The single-edge-notch specimen is well suited for obtaining experimental fracture toughness values for materials in plate and sheet forms. Experiments were conducted with single-edge-notch specimens of two shapes to compare their experimental behavior with predictions computed from the theoretical stress function for an axially-loaded notched elastic plate of specific geometry. This is sometimes called a compliance calibration. Such experimental verification of theoretical solutions increases confidence in the applicability of analytical procedures.



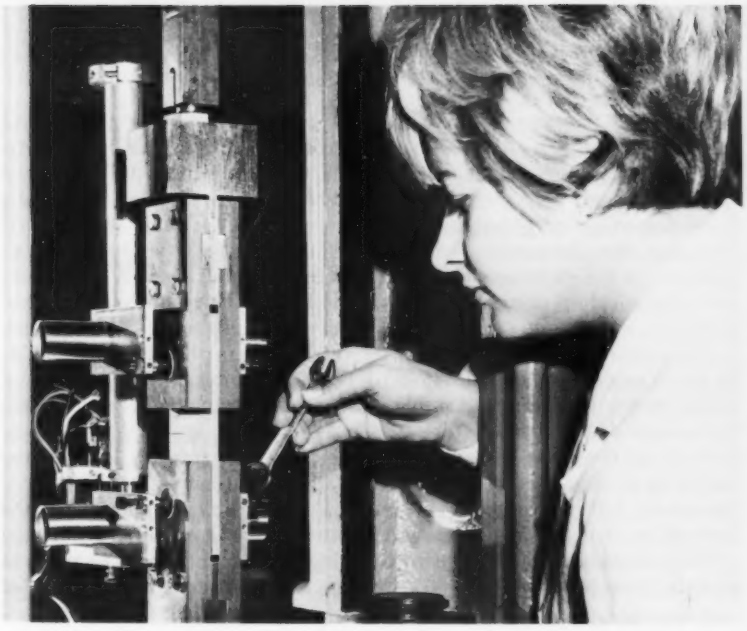
J. R. Houghton connects extensometer he developed to grips holding metal specimen. The grips will apply tension and the extensometer will measure the specimen's mechanical compliance. Extensometer has two linear variable-displacement transformers, visible at center. The core of one moves with the specimen to vary the electrical signal, while the core of the other is fixed to yield a reference signal.

NASA had asked the Bureau to assess probable sources of error in mechanical compliance calibrations of edge-notched specimens. The Bureau found that existing extensometers were not fully satisfactory for this purpose and NASA, in consequence, supported the development of the new extensometer.

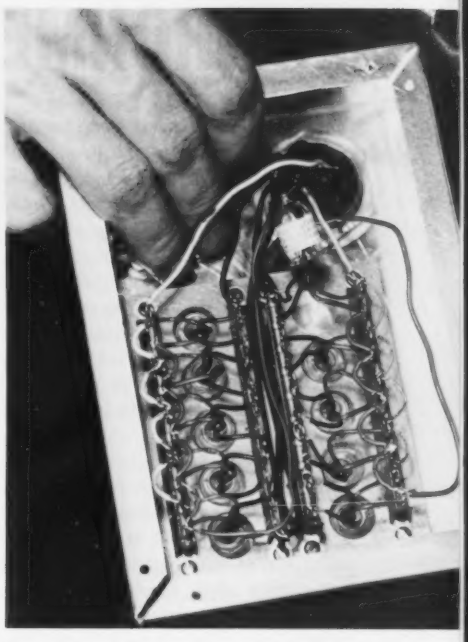
NBS EXTENSOMETER

A linear variable-differential transformer (LVDT) is used to sense displacement (motion) between two axes of the NBS extensometer, which is attached to two points on the specimen. A second, inactive LVDT supplies a reference voltage. About the size and shape of a spool of thread, each LVDT contains two windings (a primary and a secondary) around a movable core, the position of which controls the magnetic coupling between the windings and hence the output voltage.

The extensometer is used by adjusting and connecting the gage points to the specimen, clamping the transformer linkage to the extensometer column, and adjusting



Mary Jane Orloski secures a notched tensile-test specimen in a tension test machine. How much the specimen "gives" under tension will be determined by a linear variable-differential transformer, the core of which moves with the specimen. This precise displacement-measuring system has a sensitivity of 1 microinch.



Thermoelectric converters (for converting ac signals to dc) nestle in an aluminum heat sink; this unit converts signals from NBS extensometer for measurement of displacement.

and locking the initial core position of the active LVDT. The primaries of both LVDT's are then energized by an ac signal. The output from the active LVDT is thermoelectrically converted to dc and matched with the converted reference signal from the inactive LVDT, after passing through a precision voltage divider, by comparator circuitry previously developed to calibrate vibration pickups.[2] The extensometer was calibrated by means of a reference Tuckerman strain gage and an autocollimator. As an indication of the precision, the standard deviation estimated from repeated calibrations is approximately 2 microinches. The system has a sensitivity of 1 microinch.

FINDINGS

The extensometer was used experimentally to determine the compliance of 1/4-inch-thick by 3-inch-wide aluminum alloy specimens of two lengths, 15 and 8 inches overall. The longer one had an 8-inch gage length (between pivot axes) and a compliance computable by a previously developed procedure for various depths of a notch in one edge. The shorter specimen had a gage length of approximately 4 inches. The latter was of special interest because geometrically similar specimens had been used to monitor changes in ductility of materials in nuclear reactors.

The measured compliance of the long specimens was found to follow closely the compliance previously computed by Srawley and Gross[3] for notch depths up to half the specimen width, supplying experimental confirmation of the earlier analytical work and verifying the underlying theoretical assumptions.

The measured compliances for the short specimens were much greater (by factors near two over the notch range used) than calculated using the Srawley-Gross relationships. This discrepancy is not due to errors of the extensometer, but had been anticipated because deformation of material near the pin loading holes of the specimen is additive to the deformation of material near the notch. These results reinforce the caution being exercised by experimental investigators when interpreting fracture toughness data obtained from tests of specimens similar to this short specimen.

[1] Orloski, M. J., Mechanical compliance measurements of single-edge-notch tension specimens, J. Res. Nat. Bur. Stand. (U.S.), **74C** (Eng. and Instr.), Nos. 1 & 2, 21-27 (Jan.-June 1970), SD Catalog No. C13.22/sec. C:74/1 & 2.

[2] Precise determination of millivolt a-c ratios, Nat. Bur. Stand. (U.S.), Tech. News Bull. **50**, No. 6, 89-90 (1966).

[3] Srawley, J. E., and Gross, B., Stress-Intensity Factors for a Single-Edge-Notch Specimen by Boundary Collocation of a Stress Function, Nat. Aeron. Space Admin. Tech. Note D-2395 (1964).

ENVIRONMENT FOR INNOVATION

This is a condensed version of a speech delivered by Dr. Lewis M. Branscomb, NBS Director, for the Von Neumann Lecture Panel, IEEE WINCON—72, Los Angeles, February 8, 1972.

America is facing an international challenge as compelling as any in its history. It is the challenge of competition in the world marketplace, symbolized by a net deficit in the balance of trade for the first time this century.

Important as the challenge of international economic competition is to the well-being of America, a favorable balance of payments is only one of the performance characteristics of a healthy economy. Our rate of productivity has been falling, on the average, over the whole of the last century. But a rising living standard with controlled inflation must rest on raising our productivity. With 60 percent of the labor force now engaged in the service sector of the economy—where productivity grew only 0.4 percent per year during 1966–1970—it is clear that manufacturing alone cannot carry the responsibility for overall productivity improvement.

As a Nation, we should welcome this challenge to our competitiveness. Imitation, after all, is the sincerest form of flattery. More important, the impressive performance of our friends abroad serves to remind us that the ability to put science and technology to work for the benefit of the Nation as a whole is not unique to our society; technical knowledge has universal value for mankind.

The task of fostering technology of potential value to the commercial and service sectors of our economy is extremely complex. Within constraints which protect the public's well-being, private enterprise is the most effective and efficient institution for the successful exploitation of technology.

What, then, is the Federal Government's responsibility in fostering the innovative process, drawing on the enormous scientific and technical resources of this country?

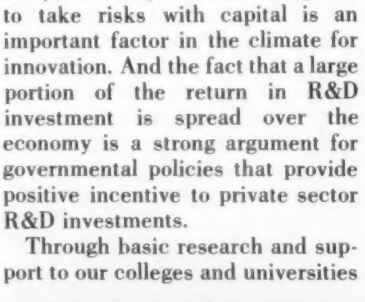
The Government's task, it seems to me, is to create the environment within which the American public, business and labor can best take advantage of the great opportunities ahead of us. We need a better environment for innovation to bring technology to the world market.

The components of this environment for innovation are:

1. The fiscal environment
2. The knowledge environment
3. The ethical and regulatory environment
4. The market environment
5. The environment of confidence and cooperation.

Although the *fiscal environment* lies outside my area of responsibility, I can say that the willingness to take risks with capital is an important factor in the climate for innovation. And the fact that a large portion of the return in R&D investment is spread over the economy is a strong argument for governmental policies that provide positive incentive to private sector R&D investments.

Through basic research and support to our colleges and universities



to ensure a steady supply of well-trained and motivated young people, the Government provides an indispensable part of the *knowledge environment* for innovation. But in addition to basic scientific knowledge and engineering know-how, the Federal Government, in cooperation with industry and the universities, has the duty to provide the applied research and services that distribute and enhance the usefulness of practical knowledge. This is the primary job of the National Bureau of Standards.

Part of a strategic approach to the national R&D enterprise must be a clearer recognition of the needs of the technological infrastructure of the economy. In the evolution of technology there are many elements that should not be taken for granted. First is the process of quantification of knowledge, without which prediction—and therefore engineering—is not possible. Fostering and organizing the *knowledge environment* for innovation could sharply narrow the gap between the scientific frontier and the engineering state-of-the-art. Second is the need for verification of technical information so that those who would apply it can rely on it. These two processes are a major concern to us at NBS and to the hundreds of companies with which we enjoy common research interests.

A number of programs proposed for expansion at NBS that contribute to this *knowledge environment* include the science of failure avoidance in materials and structures, new ways to measure the performance of computer networks and software, and the development of new measuring tools and test methods for evaluating the compatibility of proposed technologies with performance criteria.

Part of our national strategy should be the development of user-oriented research leading to organized, readily applicable scientific and technical knowledge. Our present information systems, many of which were created in response to an overwhelming supply, could be stimulated by increased demand if their content is improved.

The *regulatory environment* is important because many Americans do not appreciate that regulation often needlessly inhibits innovation. The regulatory process, if based on carefully prepared performance criteria, can actually be an incentive, not a bar to innovation. If the mandatory standards are performance oriented and are supported by well-verified measurement methods, we may escape a decade of endless litigation in the courts while the environment continues to degrade and unsafe products continue to enter the market.

The most potent force for expanding private sector innovation is a market that demands it. If we look carefully at the areas of American life where technology has not yet contributed as much as it should, we usually find that the market is fragmented. Fragmented markets are often served by fragmented industries, and individual companies may lack the economies of scale to justify the R&D that provides for innovation.

The voluntary standards process is an important mechanism for aggregating markets. If local needs can be identified on a national level and incorporated in performance-based standards for use in purchase specifications, manufacturers may see a large enough market to justify research leading to improved products. The standards-making process offers opportunities on a broad scale to increase industrial efficiency, and hence productivity, by simplifying designs and practices and promoting compatibility along the chain of activities leading from manufacturer to customer.

Incompatibilities between U.S. practices and those of other nations can be significant non-tarrif barriers to trade. Elimination of these technological barriers is one of the most important benefits to be sought in going metric. The Secretary of Commerce, Maurice Stans, has recommended to Congress a 10-year program of conversion. The President has called attention to the potential of such a conversion program for raising U.S. competitiveness. Should the U.S. go metric, industry might find many opportunities for improving the efficiency of the economy through improved standards.

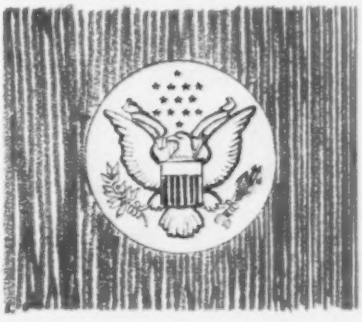
By an improved *environment of confidence and cooperation* I mean the vital importance of a positive, cooperative outlook on America's economic future. Most of the opportunities for improving the environment for innovation lie within the private sector and require the joint efforts of industries and labor groups. A close examination of the efforts of other nations to put their governments behind efforts to increase their competitiveness suggests that we need a new climate for industry-government cooperation. No one has said this better than Dr. Gordon F. Bloom, who recently spoke on Improving Productivity in the Food Industry. He concluded:

> ... the nature of technological progress has become so complex that the days when productivity changes of a significant nature could be made on a company-by-company basis are gone. We can limp along as we have in the past with an improvement rate of 1-2 percent per year, or we can set our sights on 5 percent or more per annum. If we choose the latter, we may require a new form of alignment between government and business.

How might we in Government proceed to explore a new form of alignment with business? What programs might Government undertake that could improve the environment for innovation and give the private sector more incentive to put research to work in the commercial economy?

The answer is that some carefully designed experiments are needed. The President proposed in his 1973 Budget message to the Congress that the NBS establish an Experimental Technology Development and Applications Incentives Program to respond to this experimental approach.

The purpose of the NBS proposed program is to investigate—by actual experience in cooperation with the private sector—the usefulness of a variety of incentives and mechanisms to stimulate the generation and application of private research and development in ways that will make our economy more competitive, improve its productivity and provide new technological solutions to national problems. As the program proceeds we expect it to result in some very useful science and engineering. But the primary result will be better un-

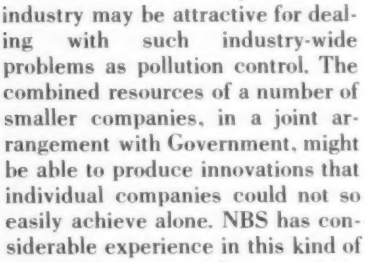


derstanding of the market environment for research and innovation and new experience with ways in which industry can seize the opportunities afforded by our national investment in science and technology.

We in Government do not have all the answers. We believe that the profit motive is still the best incentive for private sector R&D. Thus we will look for cost-sharing programs, where the commitment of the company or industry gives confidence that the technology will find its way to the marketplace, and that something of permanent value for the country can result.

A number of types of experiments are under consideration. The first step will be to enlist the cooperation of the private sector in identifying industry-wide technical opportunities for increasing the industry's competitiveness. In this process, we might look for new ways through which the industry might become better informed about foreign technological developments.

The possibility of aggregating the research and development capabilities of a number of companies in an industry may be attractive for dealing with such industry-wide problems as pollution control. The combined resources of a number of smaller companies, in a joint arrangement with Government, might be able to produce innovations that individual companies could not so easily achieve alone. NBS has considerable experience in this kind of cooperation, usually working through industrial associations.



Another class of experiments would look at the process whereby worthwhile inventions are brought to market through technology-based new ventures. Once the existence of a market for a new invention has been demonstrated and the entrepreneur has assembled the needed skills to turn an innovation into a new business, venture capital may not be hard to find. But this first step is often a major stumbling block, and NBS might explore new forms of assistance at this stage, in consultation with the Small Business Administration.

A third class of experiments might deal with the improved utilization of Government-held innovations. A recent change in the Federal Government's patent policy makes provision for exclusive licensing of Government patents under certain circumstances. Alternative arrangements for licensing Government patents to insure their exploitation might be worthwhile. The Government might also acquire foreign protection for such patents as a further incentive to domestic exploitation.

The Government laboratories, themselves, are sources of technology that can contribute to productivity increase in private industry, and sometimes to new products. Experiments involving joint projects with commercial organizations might demonstrate whether better ways can be found of bringing to market the technology produced in the Government's own establishment.

Sometimes a useful innovation is not marketed because uncertainty about the initial market makes the investment too risky. Government procurement can provide a mechanism for reducing that risk while still protecting the Government's interest as a consumer. The development of product specifications that extend the state-of-the-art—in performance or durability—can provide a private sector target for product development efforts.

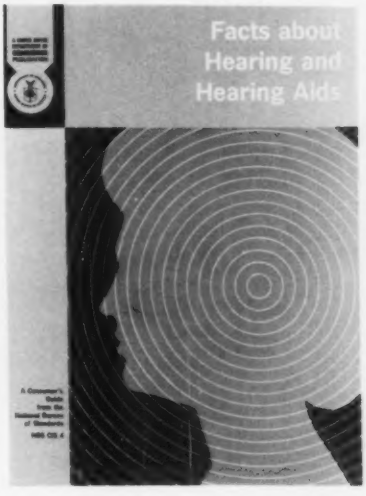
Technology may also be stimulated by market aggregation. Under the proposed program, NBS would look to private sector standards-developing and coordinating bodies for assistance in identifying experiments to enhance the standards process as means for productivity improvement.

Finally, the proposed NBS program would focus on collaboration with industry to identify and advance technologies which have potential of enhancing productivity across a broad sector of the economy. Examples of such technologies are critical materials technologies, failure-prediction methods, on-line quality control techniques, mathematical optimization methods adapted to networked minicomputers, and telefactors. A variety of means for exploring and diffusing such techniques might be attempted, ranging from studies, symposia, demonstration test, adaptive research, and jointly sponsored programs to advance the state-of-the-art.

No one expects this program of experiments to make a short-term impact on the U.S. economy as a whole. The results of the experiments would have to be evaluated, along with the National Science Foundation program and the experience of other agencies, by the Office of Science and Technology and the Office of Management and Budget in order to determine future strategies for enhancing our national R&D capability and putting it to work for public benefit.

From the experiments themselves, the most valuable result would probably be the shared experience by Government, industry and other R&D organizations of working together. A national R&D strategy must be designed to achieve an environment for innovation within which all sectors of our national life will cooperate for the benefit of all.

CONSUMER GUIDE ON HEARING AND HEARING AIDS



It is estimated that 20 million Americans have a hearing problem. Some have shrugged and accepted it as a natural burden they must live with as their hearing continues to deteriorate. Others, more fortunate, have sought proper treatment to conserve as much natural hearing ability as possible and have obtained appropriate hearing devices to allow them to continue to lead normal lives. A new booklet, *Facts About Hearing and Hearing Aids*, was prepared specifically to inform those with hearing losses of the help that is available to them, and is the fourth in a series of consumer guides prepared by the Bureau in its continuing efforts to help consumers make intelligent decisions in the marketplace.

In commenting on the booklet, Dr. Lewis M. Branscomb, NBS Director, stated, "We hope the public will take advantage of the depth of information we have gathered here for persons who are concerned about a loss of hearing. We have spared no effort in making this booklet comprehensive, accurate, and fully informative, and at the same time practical and down to earth so that it can be readily understood by the layman."

"The booklet explains the construction of the ear and how it works," continued Dr. Branscomb, "as well as causes of hearing loss and proper treatment. This may range from simple removal of wax by the family doctor up to delicate surgery by specialists in the field. I believe the sections on selection, adaptation, and maintenance of hearing aids will be of great value to everyone with a hearing problem. For those members of our society not affluent enough to afford proper treatment and hearing aids, the information on financial assistance should be of special interest."

The Bureau, in preparing *Facts About Hearing and Hearing Aids*, has gone to considerable effort to provide the best and most reliable information available on the subject of hearing. Key illustrations have been prepared by one of the Nation's leading medical artists. Medical advice and data, as well as information on hearing aids, have been supplied by the American Speech and Hearing Association; the American Academy of Ophthalmology and Otolaryngology; the Army Audiology and Speech Center (Walter Reed General Hospital), Department of the Army; the National Institute of Neurological Diseases and Stroke of the National Institutes of Health, Department of Health, Education, and Welfare; the Prosthetic and Sensory Aids Service, and Auditory Research Laboratory, Veterans Administration; and the National Association of Hearing and Speech Agencies.

Facts About Hearing and Hearing Aids, written by Edith Corliss and edited by James E. Payne, may be purchased, like its three predecessors in the Consumer Information Series, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or from the nearest Department of Commerce field office or Government book store at 60 cents a copy. The booklet may also be obtained from Consumer Product Information, Washington, D.C. 20407.

Previous publications in the series were entitled *Fibers and Fabrics*, *Tires—Their Selection and Care*, and *Adhesives for Everyday Use*. In preparation are others dealing with care of books and documents, flooring, plywood, and a variety of other leading consumer areas.

William Croll places a specimen of p-type germanium into a vacuum evaporation apparatus to deposit a layer of lithium metal on one surface. Upon heating, the diffusion of lithium into the germanium will cause the formation of an n-type layer.

An infrared monochromator system is prepared for recordin radiation detector mounted at the bottom of a cryostat-dew Here William Keery adjusts the processing and recording ci as Alvin Sher inserts a card to momentarily interrupt the li

EVALUATING NUCLEAR RADIATION

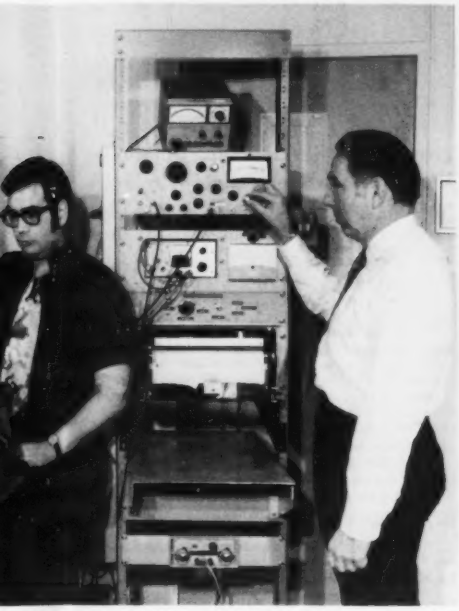
Recent research in the semiconductor processing and materials characterization laboratories of the Institute for Applied Technology has had as its objective the advancement of technology for making and using lithium-compensated germanium (Ge(Li)) radiation detectors. This work has been conducted by A. Sher and W. Keery, assisted by W. Croll, R. Thurber, and H. Dyson, under Dr. Sher's guidance, for the Atomic Energy Commission, which has an interest in the development of nuclear radiation detectors. Results from continuing NBS work on semiconductor detector performance and on characteristics of the material from which detectors are fabricated have aided suppliers of germanium single crystals, fabricators of Ge(Li) gamma-ray spectrometers, and users of these devices.

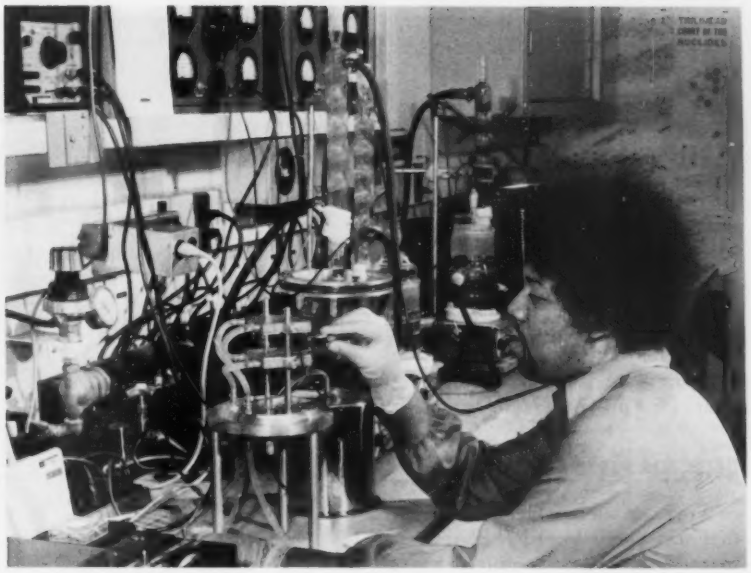
SEMICONDUCTOR NUCLEAR RADIATION SENSORS

Lithium-drifted germanium gamma-ray detectors are particularly useful in nuclear measurements because of their excellent energy resolution. They are made by diffusing elemental lithium into the surface of a *p*-type germanium crystal and then applying an electric field to drift the lithium in further, forming an "intrinsic" layer—one having a low concentration of free charge carriers—between *n* and *p* layers. Because of this geometry these devices are sometimes called *p-i-n* diodes.

The lithium-drifting technique had been successfully used for some years when the detectors being produced were suddenly found to be defective. The difficulty was traced to the starting material, *p*-type germanium, but no obvious cause was found for the defective material and no simple methods were known for identifying good germanium, other than taking the 8 to 10 weeks necessary to process a

ed for recording the response of a semiconductor cryostat-dewar assembly (cone-topped vessel). nd recording circuitry to obtain a null reading nterrupt the light beam.





Howard Dyson inserts a lithium-diffused germanium specimen into an apparatus for "drifting" the lithium into the germanium to produce a "compensated" region—one having few free charge carriers. The specimen will be clamped between the two temperature-controlled copper blocks, which will apply a high dc voltage across the specimen. When the cover (beyond the tripod stand) is placed over the apparatus, the germanium specimen will be surrounded by an inert gas.

TION DETECTORS

specimen of the material. This situation established the need for NBS work in this field.

RESEARCH ON MATERIALS

Primary objectives in the Bureau's research on semiconductor detector materials have been methods for rapidly determining the suitability of germanium crystals for fabrication into detectors and identification of the causes of poor quality in germanium crystals. One of the findings has been that measurement of the electron drift mobility in a *p*-type germanium crystal does not correlate with the lithium-ion drift mobility and therefore cannot be used as a measure of crystal quality.[1] Similarly, the electron drift mobility was found not to be useful as a measure of the oxygen concentration in *p*-type germanium.

Measurements of oxygen concentration in germanium at levels below 20 parts per billion have been

Robert Thurber slides a cryostat assembly into position in an infrared spectrophotometer in preparation for measuring the oxygen concentration in a specimen of germanium. The absorption of the test specimen (contained in the cryostat on the right) will be compared with that of a reference specimen known to contain a negligible amount of oxygen (in cryostat on left) and the difference recorded on the drum chart (left).

studied in detail, as this impurity has been shown to adversely affect the lithium-ion drift mobility.[2] This mobility is an important material acceptance criterion for germanium to be used for making Ge(Li) detectors. A method for its measurement, based on a procedure developed at NBS,[3] was recently accepted for use as a tentative standard by the American Society for Testing and Materials.[4] The method has the advantage of yielding the required parameter after only 3 hours of measurement, as compared to 100 hours for a previous technique.

DETECTOR PERFORMANCE

Work on detector characterization was carried out in order to aid in interpreting semiconductor measurements on materials. The first experimental determination of the upper limit of the Fano factor in germanium was performed by Dr. Sher and W. Keery.[5] This factor is a quantity used to express the difference between the experimentally determined semiconductor detector energy resolution and the larger, theoretically predicted value. The Fano factor is often used as a measurement of detector quality with regard to the trapping of charge carriers, which results in deterioration of energy resolution.

Dr. Sher and W. Keery used a collimated beam of gamma rays to irradiate selected regions of a Ge(Li) detector in order to separate the collection of charge due to electrons and that due to holes within the device. The Bureau's measurements led to a value of 0.11 for the upper limit for the Fano factor, rather than the then-accepted value of 0.13. This lower value indicates that the resolution of Ge(Li) detectors is not as good as expected and that higher gamma-ray energy resolution might be obtained with improved material quality. Subsequent measurements at other laboratories indicate that Fano factors in some detectors may be as low as 0.08.

An operational model for carrier trapping in Ge(Li) detectors was developed to simulate, on a digital computer, experimentally obtained gamma-ray spectra in order to gain information on such parameters as electron and hole lifetimes, which data are not accessible by other means.[6] The model also showed how variation of the charge-carrier lifetime (a function of the electric field applied to the detector) causes distortion of the symmetrical gamma-ray photoelectric interaction peak in a spectrum displayed as a plot of number of events versus energy.

In order to aid people who fabricate, test, and use Ge(Li) detectors, a series of six nomographs was produced, covering calculations routinely used in fabricating detectors and measuring their quality.[7] Use of these nomographs eliminates the need for repeated complex calculations and permits simple comparisons to be made betweeen sets of detector or material parameters.

For the purpose of improving the specification of detectors at the buyer-seller interface, Drs. Sher and J. Coleman directed the development of a voluntary standard for germanium gamma-ray detectors, in cooperation with the IEEE Nuclear Instruments and Detectors Committee.[8] Several of the test procedures developed at the Bureau were chosen for inclusion in the standard because of their objectivity and ease of computation.

PRESENT RESEARCH

Current research, part of a Joint Program on Methods of Measurement for Semiconductor Materials, Process Control, and Devices, is directed toward an improved infrared response technique for determining defect and impurity levels in semiconductors.[9] In this technique the change in detector current is monitored as a function of incident infrared wavelength, making possible appraisal of defects and impurities that degrade detector performance through carrier trapping. Use of this technique might enable manufacturers of detector-grade germanium to remove material from processing that would cause poor performance and to adjust crystal-growing procedures to minimize thermal defect formation. Preliminary results indicate that the method is sensitive enough to detect gold at a concentration of approximately 1×10^{11} atoms/cm^3 (2 parts in 10^{12}).

[1] Sher, A. H., and Thurber, W. R., Minority carrier and lithium-ion drift mobilities and oxygen concentration in *p*-type germanium, J. Appl. Phys. **42**, 4508-4509 (1971).

[2] Sher, A. H., Croll, W. K., and Thurber, W. R., Determination of oxygen in germanium below 20 parts per billion by measurements of lithium mobility and precipitation, Anal. Chem. **43**, 1831-1834 (1971).

[3] Sher, A. H., Lithium-ion drift mobility in germanium, J. Appl. Phys. **40**, 2600-2607 (1969).

[4] Method for measuring lithium-ion drift mobility in germanium single crystals (ASTM Designation F334-71T) Annual Book of ASTM Standards, Part 8 (1971).

[5] Sher, A. H., and Keery, W. J., Variation of the effective Fano factor in a Ge(Li) detector, IEEE Trans. Nucl. Sci. **NS-17**, No. 1, 39-43 (1970).

[6] Sher, A. H., Carrier trapping in Ge(Li) detectors, IEEE Trans. Nucl. Sci. **NS-18**, No. 1, 175-183 (1971).

[7] Sher, A. H., Nomographs for Use in the Fabrication and Testing of Ge(Li) Detectors, Nat. Bur. Stand. (U.S.), Tech. Note 537 (Aug. 1970).

[8] IEEE Test Procedure, Germanium Gamma-Ray Detectors, IEEE No. 325 (1971).

[9] Sher, A. H., Keery, W. J., and Dyson, H. E., Improved infrared response measurements in semiconductor nuclear radiation detectors, to be published in IEEE Trans. Nucl. Sci. **NS-19**, No. 1, 341-344 (Feb. 1972).

A continuing account of the Institute's research in semiconductor technology can be found in the series of quarterly reports edited by W. M. Bullis and published as NBS Technical Notes entitled **Methods of Measurement for Semiconductor Materials, Process Control, and Devices.** They are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. To date, the issues, periods covered, prices, and Superintendent of Documents Catalog Numbers are:

TN 472, July 1 to Sept. 30, 1968, 50 cents, C13.46:472
TN 475, Oct. 1 to Dec. 31, 1968, 45 cents, C13.46:475
TN 488, Jan. 1 to Mar. 31, 1969, 50 cents, C13.46:488
TN 495, Apr. 1 to June 30, 1969, 50 cents, C13.46:495
TN 520, July 1 to Sept. 30, 1969, 65 cents, C13.46:520
TN 527, Oct. 1 to Dec. 31, 1969, 60 cents, C13.46:527
TN 555, Jan. 1 to Mar. 31, 1970, 65 cents, C13.46:555
TN 560, Apr. 1 to June 30, 1970, 60 cents, C13.46:560
TN 571, July 1 to Sept. 30, 1970, 60 cents, C13.46:571
TN 592, Oct. 1 to Dec. 31, 1970, 50 cents, C13.46:592
TN 598, Jan. 1 to Mar. 31, 1971, 55 cents, C13.46:598
TN 702, Apr. 1 to June 30, 1971, 50 cents, C13.46:702

OPTICAL RADIATION NEWS

Optical Radiation News (ORN) is intended to serve as a means of communication among workers in industry, universities, and Government agencies involved in radiometry and photometry. ORN will focus on developments in the laboratory, in the published literature, and at the council table, which are of interest to its readers.

COUNCIL ON OPTICAL RADIATION MEASUREMENT ORGANIZED

On February 10 the Council on Optical Radiation Measurement was formally organized by a conference of 27 industrial and 32 governmental representatives. This meeting was held at the National Bureau of Standards under the title, "Second Conference on the Definition of Pressing Problems and Projected National Needs in Radiometry and Photometry."

The first such conference was held October 28, 1971. The formation of the Council resulted from recognition at this first Conference that its definition of measurement problems must be followed immediately by an action program and for this purpose a permanent organization was necessary.

CONNECTION WITH CIE

Rather than set up a wholly independent structure, the Council decided to operate as an activity of U.S. CIE Technical Committee 1.2 on Photometry. This step was taken for several reasons. The program of the CIE is also focused on the achievement of solutions to immediate problems. These problems are addressed by laboratory experimentation and development, by intercomparison of measurements among laboratories, and by examination of the techniques and assumptions on which the measurements are based; that is, the definition of the system. Solutions are undertaken both on a national and an international basis.

Technical Committee 1.2 will constitute the guiding body of the Council. The Committee, as recently reconstituted, consists of representatives from the instrumentation, detector, lamp, photographic, television, and transportation industries. It includes Federal Government and university representation as well.

PROGRAM

The long-term program that the Council adopted at its initial meeting consists of four stages:

1. Identification of the most serious measurement problems in radiometry and photometry (February).
2. Completion of a quantitative review of these problems along with a detailed justification of importance (May).
3. Dialogue with NBS concerning potential standards and services designed to meet the problems identified in step 2.
4. a. Formal requests from the Council to NBS for specific measurement standards services—
   b. Reply by NBS.
   c. Examination of independent Council action.
   d. Inauguration of topical conferences.
   e. Monitoring of progress toward stated goals by NBS and by the Council (November).

PROGRESS TO DATE

The primary task the first Council session undertook was the drafting of specific requirements for standards, techniques, and services now unavailable. For this purpose the Council formed seven Working Groups:

I. Geometrically Total Flux Measurement
II. Laser Power and Energy Measurement
III. Classical Radiometry and Photometry: Radiance, Irradiance, and Intensity
IV. Infrared Measurement
V. Detector Characterization
VI. Techniques in Radiometry and Photometry including Spectrophotometry
VII. Dissemination of Measurement Capability and Performance

Each of these Working Groups is now completing its draft of detailed specific measurement requirements and compiling a record of the impact of the specific measurements discussed. Before the second Council meeting in May these requirements and their justification will be reviewed by all Council participants.

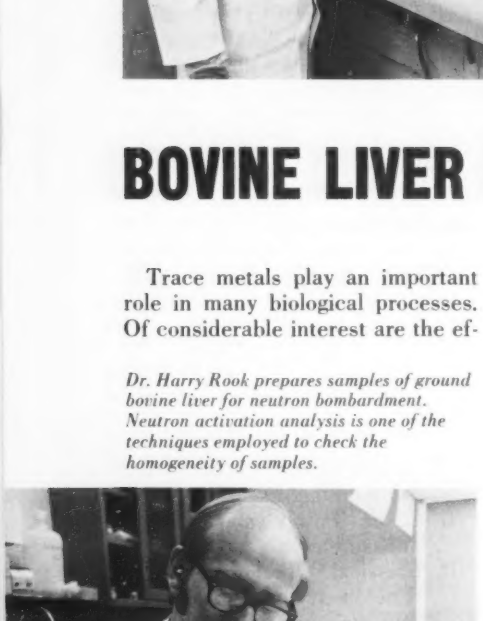
continued on page 95

Irradiated samples of bovine liver are chemically prepared by Thomas Gills, prior to analysis for their trace element content. Certification values for 11 trace metals and information values for nine others have been obtained.

BOVINE LIVER AND TRACE METAL ANALYSIS

Trace metals play an important role in many biological processes. Of considerable interest are the effects of trace metals on the metabolism and disease of plants and animals. Variations in the quantities of trace metals in organisms and the extent to which these variations may be influenced by environmental pollutants, such as pesticides, are also of major concern. In addition, trace metals are used in the development of improved analytical analysis procedures.

Dr. Harry Rook prepares samples of ground bovine liver for neutron bombardment. Neutron activation analysis is one of the techniques employed to check the homogeneity of samples.



As more and more measurements of the trace element content of tissues and fluids are reported, a common basis for meaningful interlaboratory comparisons of data becomes essential. To fulfill this need, the Office of Standard Reference Materials and the Analytical Chemistry Division, in work partially sponsored by the Atomic Energy Commission, have cooperated in the production of a new biological Standard Reference Material, Bovine Liver, which will be issued as SRM 1577.[1] The liver, certified for 11 trace elements, together with the botanical SRM released last year,[2] will meet the criteria necessary for establishing reference points for effective interlaboratory comparison. In addition, the low-level radioactivity values for potassium-40 and cesium-137 are certified.

Selection of liver for development as a Standard Reference Material was influenced by several factors. Because the liver acts as a clearinghouse for many of the body processes, its trace element content is higher and more varied than that of other body organs. Liver is readily available, therefore not expensive, and its low-fat content simplifies the freeze-dry process.

This Standard Reference Material was prepared from approximately 1,100 pounds of fresh bovine liver from which the fat and major blood vessels were trimmed and the skin removed. The material was then ground, mixed thoroughly, and freeze-dried. The freeze-dried product was ground and packaged in glass bottles, each bottle containing about 17 grams of liver powder. After the homogeneity of the powder had been confirmed through spectrophotometric and neutron activation analyses, a comprehensive analytical program was begun at the Bureau. Methods such as neutron activation analysis; atomic absorption spectrometry; flame emission spectrometry;

polarography; isotope-dilution, spark-source mass spectrometry; thermal-ionization mass spectroscopy; and nuclear track technique were used to obtain certification values for 11 trace metals and information values for nine others. Mercury, cadmium, lead, selenium, zinc, sodium, potassium, rubidium, manganese, iron, and copper are the metals that have been certified. It is expected that the present information values determined for arsenic and eight other elements will eventually be certified.

SRM 1577, Bovine Liver, also contains trace amounts of radioactive potassium-40 and cesium-137 with values of 7.6 ± 0.6 and 0.052 ± 0.009 picocuries per gram, respectively.* The gamma-ray emission rates of these two constituents were determined by use of the Radioactivity Section's 8-in NaI(Tl), $4\pi\gamma$ low-level counting system. Knowledge of the radioactivity concentrations in SRM 1577 should prove useful to people who make radiation measurements on materials containing environmental levels of radioactivity.

The liver standard, along with the orchard leaves (SRM 1576), has already been recognized as the accepted comparison standard in the International Decade of Ocean Exploration baseline studies program sponsored by the National Science Foundation and in the U.S. AEC's Lake Michigan study. The availability of the liver SRM, together with several future biological SRM's, such as freeze-dried samples of tuna and of blood, will allow scientists all over the world to directly compare the results of their analyses.

*The stated uncertainties are the respective sums of the statistical errors at the 99-percent confidence levels (tS_m: where t is the Student t-factor, S_m is the computed standard error), and the corresponding maximum uncertainties due to systematic errors.

[1] SRM 1577 will be available by May 1, 1972, from the Office of Standard Reference Materials, National Bureau of Standards, Washington, D.C. 20234.

[2] For a discussion of the botanical SRM see: Standard Reference Materials, Nat. Bur. Stand. (U.S.), Tech. News Bull. **55**, 231-233 (Sept. 1971).

BREAKTHROUGH *continued*

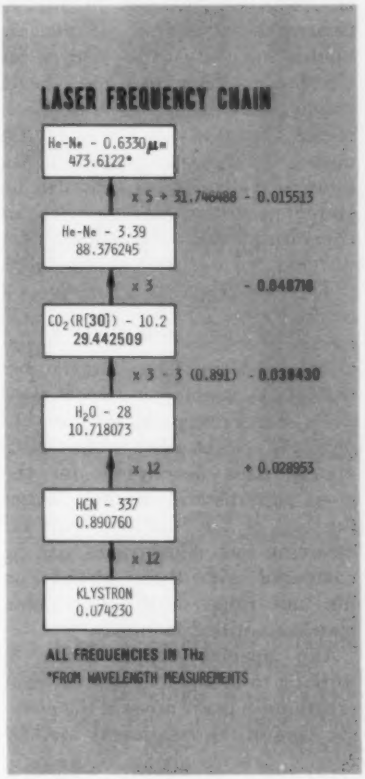
measured wavelength. However, frequency-measuring techniques are more than 10,000 times more accurate than wavelength-measuring techniques.

Development and accurate measurement of super-stable laser oscillators at frequencies approaching those of visible light—about 1 million times higher than the frequencies now used in FM radio and television—open up possibilities for a whole new frequency range for telecommunications, an increase of 200-fold over the current frequency bands presently utilized.

In the past, the most accurate speed-of-light measurement was made by measuring the wavelength and frequency of relatively low frequency radio waves. The measurement of wavelength, an essential step in the procedure, was limited at these low frequencies to an accuracy of some 300 parts per billion. At high infrared frequencies, however, the measurement of wavelength will be limited only by the accuracy of the length standard itself (about 10 parts per billion). Thus, a thirtyfold increase in the accuracy of the speed of light should be attainable.

The frequency measuring technique developed by NBS scientists K. M. Evenson, J. S. Wells, G. W. Day, and L. O. Mullen is quite similar to that used in the input stages of a common radio receiver. The helium-neon laser frequency (wavelength of 3.39 micrometres) is measured by using a specially constructed diode as a harmonic generator and mixer. The diode multiplies accurately-known lower frequencies (from other lasers and microwave generators) to obtain a signal that is approximately equal to the unknown frequency being measured. The same diode then mixes in the unknown frequency and produces a signal equal to the difference between the unknown and known frequencies. This low frequency difference (of a few million hertz) is then measured using well-established methods. The diode that accomplishes this harmonic generation and mixing is a microscopic version of the old-catwhisker diode used in the early days of radio. Only one ten-thousandth of an inch in diameter, the sharpened tungsten wire catwhisker touches a nickel surface to form the diode, and the wire itself is the anntenna for the laser radiation.

[1] Evenson, K. M., Day, G. W., Wells, J. S., and Mullen, L. O., Extension of absolute frequency measurements to the cw He-Ne laser at 88THz (3.39 μm), Appl. Phys. Letters **20**, No. 3, 133 (Feb. 1, 1972).



This diagram represents the steps that will be undertaken in project designed to improve the accuracy of the methane stabilized He-Ne laser frequency measurement by a factor of 100. The frequency measurement of a visible laser, shown at the top, is a future objective of the program.

IDENTIFICATION OF PATIENTS BY FOOTPRINTS

NBS ADAPTS SCHEME FOR DRUG ABUSE PROGRAM

A method has been developed for encoding the ridge patterns of footprints, using descriptors for gross patterns and for the type and location of minutiae. The latter are notated by means of a grid placed between a delta and core of the ridge pattern on the ball of the foot.

Recording footprints, a hospital practice for preventing mixups of infants, is now being extended to adults to verify admissions in drug treatment programs dispensing methadone. The NBS Center for Computer Sciences and Technology, U.S. Department of Commerce, adapted an FBI footprint classification system for use with numerical descriptors that can be stored in a computer memory for comparing footprints in searches for matches.[1]

The technique was developed by the Center's Joseph H. Wegstein for the President's Special Action Office for Drug Abuse Prevention, which was seeking a way of positively identifying patients to prevent multiple registration. The NBS system uses descriptors for the gross patterns and minutiae across the ball of the foot; notations for incoming foot photographs can be compared with those already on file and ridge detail of possible matches verified manually.

The Special Action Office is working to broaden drug treatment programs in many areas of the country. One of the treatments used by clinics involves giving methadone, which, though itself an addictive drug, can be used in carefully controlled dosage to assist in reducing patient dependence on heroin. Program administrators recognized that some means must be found to prevent patients from registering under different names or at more than one clinic to receive extra methadone—for their own use or for resale on the black market. In order to prevent this, the administrators asked the NBS Computer Center to recommend a foolproof method of identifying duplicate registrants, while preserving the confidentiality of patient information.

PERSONAL IDENTIFICATION BY FOOTPRINTS

Fingerprints—an obvious first choice—were ruled out as the means of identification because of the patients' suspicion that their fingerprints might be related to previous records. It being well known that some areas of the soles of the feet can be used to verify identity, Mr. Brian Le Bert-Francis of the Special Action Office requested instead the use of footprints. Mr. Wegstein explored various alternative areas of the foot and recommended that the ball of the foot be used. Its ridge characteristics are unchanging, like those of fingerprints, and likewise include ridge endings, beginnings, splittings, mergings, islands, "skips," "kisses," loops, and deltas.

NOTATION FOR FOOTPRINT DESCRIPTORS

The new system gives for each right foot a descriptor for the pattern below the great toe, a descriptor for other gross patterns across the ball of the foot, and the distance between a core and delta of the gross pattern below the great toe. A central file of the complete alpha-numeric descriptor for all registrants in the system can be compared manually for matches with the notation for the footprint of each new registrant at all participating clinics. As is the case with fingerprints, reproductions of the footprint for each preliminary match found must be compared visually for positive identification. If a match is confirmed, the clinics involved would be informed; if no match is found, a randomly chosen ID number would be issued to the new registrant and his print entered in the national file.

CODING DESCRIPTORS FOR COMPUTERIZED SEARCH

In view of the probable size of the descriptor file and to permit a rapid return of search results, Mr. Wegstein was requested by the

Special Action Office to develop a method for match searching by computer. The method recommended adds a descriptor based on the type and location of ridge minutiae. The location of each minutia is obtained by use of a reticule, or transparent grid, positioned with its x-axis tangent to the innermost curve in the pattern core and passing through the associated delta. The data listed for each minutia, going from left to right, are a zero (for ridge endings and mergings) or one (for ridge beginnings and splittings) and its x and y coordinates.

The manual and minutiae descriptors—the latter typically numbering 5 to 25—for each print are read into the computer memory to establish the file for the prints of patients in the treatment system. The set of descriptors for the right footprint of each incoming patient is entered into the computer, which then searches the file for a match. If none is found, the descriptors are inserted in the file along with a notation giving the print's source. The footprints for any possible matches identified by the computer must be compared visually to determine an actual match; when this occurs, the system would identify the source of the matching print to the clinic seeking to register the patient, for its action to prevent multiple registration.

The algorithm used by the computer in comparing footprints is a simplified version of one previously developed at the Bureau. The amount of descriptor discrepancy for which the program will call a match is adjustable and can be set to produce enough preliminary matches to increase the likelihood that a duplicate, if on file with slightly different descriptors, will appear among the matches. Software development is still required to make this program efficient and economical.

Footprints can be obtained by a camera similar to that used by hospitals to photograph the feet of newborn infants. A Polaroid print of the patient's foot can be made during his initial examination when entering an addiction treatment program. The print would be sent to a proposed Admissions Clearinghouse, where it would be classified and coded for match searches of the existing file. The registering clinic would then receive a report of any matches found and verified. Confidentiality of patient information would be assured by including no names on file with the print.

The fundamentals of such a program have been used experimentally by the District of Columbia Narcotics Treatment Administration, which will soon begin a pilot test of the Admissions Clearinghouse.

Members of the staff of the President's Special Action Office for Drug Abuse Prevention demonstrate the use of a footprint camera to identify addicts seeking treatment. NBS developed a method using a computer to find matches among footprints for determining if a patient is already receiving methadone (a heroin substitute) from a clinic.

[1] Wegstein, J. H., Manual and Computerized Footprint Identification, Nat. Bur. Stand. (U.S.), Tech. Note 712, available as SD Catalog No. C13.46:712 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

NSRDS NEWS

The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.

COBLENTZ SOCIETY INFRARED REFERENCE SPECTRA

Volumes 7 and 8 of the *Coblentz Society Evaluated Infrared Reference Spectra* have been published under the auspices of the Joint Committee on Atomic and Molecular Physical Data. Each volume contains 1,000 high-quality (Class II and III) spectra. Class II spectra have been defined by the Coblentz Society as those spectra, which conform to specified precision criteria, and which have been obtained from pure compounds whose structures are verified and documented. Class III are spectra obtained from compounds of verified structures or are consistent with the nominal chemical composition to be determined by competent evaluators. Included are many organic compounds whose spectra have not been previously available in the literature (see NSRDS NEWS, December 1969). Volumes 7 and 8 as well as their earlier predecessor, Volume 6, issued in three loose-leaf sets of binders. These three volumes of evaluated spectra are available through Sadtler Research Laboratories, 3316 Spring Garden Street, Philadelphia, Pa. 19104. The cost, including binders, is $225 per volume.

CINDA 71

CINDA, the *C*omputer *I*ndex of *N*eutron *Da*ta, is an index to the literature on microscopic neutron cross sections. CINDA contains bibliographical references to measurements, calculations, and evaluations of neutron cross sections and other microscopic neutron data. CINDA 71 supersedes previous editions of this Index. CINDA 71 consists of a large volume and two supplements which cover the literature up through October 1971.

The compilation and publication of CINDA are the result of worldwide cooperation involving four information centers, each responsible for compiling the CINDA entries from literature published in a defined geographical area noted in parentheses below:

1. The U.S. AEC Technical Information Center, P.O. Box 62, Oak Ridge, Tenn. (United States and Canada).
2. The U.S.S.R. Nuclear Data Centre at the Fiziko-Energeticheskij Institut, Obninsk, Soviet Union (U.S.S.R.).
3. The ENEA Neutron Data Compilation Centre at Saclay, France (OECD member countries in Western Europe and Japan).
4. IAEA Nuclear Data Section at Vienna, Austria (all other countries in Eastern Europe, Asia, Australia, Africa, Central and South America; also IAEA publications and translation journals).

In addition to the published CINDA books, up-to-date computer retrievals for specified CINDA information are currently available on request. For CINDA computer retrievals, as well as for exchange of information, scientists should contact their appropriate centers.

For the United States and Canada:

Mr. Lawrence T. Whitehead
Science and Technology Branch
U.S. Atomic Energy Commission
Technical Information Center
P.O. Box 62
Oak Ridge, Tenn. 37830

For U.S.S.R.:

U.S.S.R. Nuclear Data Centre
Fiziko-Energeticheskij Institut
Obninsk
Soviet Union (U.S.S.R.)

For other OEDC countries:

Dr. H. Liskien
Centre ENEA de Compilation de
Donnees Neutroniques
B.P. 9
F-91 Gif-sur-Yvette
France

For all other countries:

Dr. J. J. Schmidt
IAEA Nuclear Data Section
Karntner Ring 11
A-1010 Vienna
Austria

TRANSLATION OF CRITICAL COMPILATION FROM THE U.S.S.R.

Properties of Liquid and Solid Hydrogen by B. N. Esel'son et al. ($3) is the latest publication from the U.S.S.R. Committee of Standards, Measures and Measuring Instruments, in the series initiated by GSSSD (State Service for Standard and Reference Data), which are translated and published for the U.S. Department of Commerce and the National Science Foundation. Properties covered for liquid hydrogen include density, pressure of saturated vapor, heat of vaporization, specific heat, thermal conductivity, surface tension, ortho-para interconversion, phase equilibria, electrical and optical polarization, velocity of sound, diffusion, and viscosity. Properties covered for solid hydrogen include density, isothermal compressibility, dependence of melting point on pressure, pressure of saturated vapors, heat of fusion, specific heat, thermal conductivity, dielectric constant, and velocity of sound. This translation may be ordered under the number TT 70-50179 for the price indicated from the National Technical Information Service, Springfield, Va. 22151.

INTERNATIONAL ASSOCIATION FOR THE ADVANCEMENT OF HIGH-PRESSURE SCIENCE AND TECHNOLOGY

A new international organization has been established which may be of interest to many readers of NSRDS NEWS. This organization is known as AIRAPT (Association Internationale Pour L'Avancement de la Recherche et de la Technologie aux Hautes Pressions) or the International Association for the Advancement of High-Pressure Science and Technology.

The Association's objective is the advancement of science and technology in the field of high pressures, by:

a. the promotion of contacts and cooperation between scientists and organizations of different countries with interests in scientific research, technology, and development in high pressures and related fields;
b. the organization of conferences and meetings of an international character;
c. the collection and dissemination of information;
d. the promotion of cooperative research and development.

Type of membership in the Association includes Individual Members; Honorary Members (individuals distinguished by their contributions to the science and technology of high pressures); and Delegate Members representing nonindustrial associations, research centers, laboratories, etc., which have similar objectives to AIRAPT (each organization being represented by one delegate, who should have appropriate scientific or technological qualifications). Industrial organizations who wish to affiliate with AIRAPT may each be represented by an observer.

The admission of new Individual and Delegate Members is subject to confirmation by the General Assembly. Individual and Delegate Members pay an annual subscription; Honorary Members are not required to pay any subscription.

The Association is administered by an Executive Committee, whose current officers and members are as follows:

VODAR, B., President, Professeur, Directeur du Laboratoire des Hautes Pressions du Centre National de la Recherche Scientifique, 4, Place Aristide Briand, Bellevue (S. & O.), France.

PUGH, H., LI.D., Vice President, Dr., National Engineering Laboratory, Materials Group, East Kilbride, Glasgow, Great Britain.

ANDERSON, O., Vice President, Dr., Lamont Geological Laboratory, Columbia University, Palisades, New York 10964, U.S.A.

DEFFET, L., General Secretary, Dr., Vice-president et directeur de l'Institut Belge des Hautes Pressions, Bosdellestraat, 120, 1960 Sterrebeek, Belgium.

FRANCK, E. U., Treasurer, Professor, Direktor des Institutes fur Physikalische Chemie and Elektrochemie der T. H. Karlsruhe, Kaiserstrasse, 12, Karlsruhe, West Germany.

Anyone interested in further information concerning the Association should write to Professor Vodar at the above address.

STANDARD X-RAY DIFFRACTION POWDER PATTERNS

NBS Monograph 25, Section 9, *Standard X-Ray Diffraction Powder Patterns*, by Howard E. Swanson et al., the 19th in a series of publications on x-ray diffraction patterns is now available from the Superintendent of Documents, U.S. Government Printing Office (SD Catalog No. C13.44:25/sec.9, $1.25). In this installment, standard x-ray diffraction patterns are presented for 63 substances.

INDUSTRIAL NEEDS FOR CRITICALLY EVALUATED P-V-T DATA OF ETHYLENE AND RELATED SUBSTANCES

A symposium on P-V-T data of ethylene and related substances will be held under the auspices of the Numerical Data Advisory Board of the National Academy of Sciences-National Research Council, and the NBS Office of Standard Reference Data, June 13–17, 1972, at Airlie House, Warrenton, Va.

The Symposium is planned as a technical meeting, focusing on data needs for custody transfer calculations, and equipment design calculations. In addition to P-V-T data, other property data estimated from P-V-T data will be included, as well as independently

measured data (e.g. on transport properties) to be used with P-V-T data in the calculations referred to.

The meeting will provide a focal point for discussions between interested persons in industry, universities, and government. Invited papers will be presented, and time will be allotted to present short informal contributions. In keeping with the informal character of the meeting, the papers will not be published. Also, panel sessions will be held on several topics for the benefit of the participants and the Office of Standard Reference Data at NBS. The conclusions arrived at by the panels will be written up and distributed to the attendees. Panels will identify needs for data evaluation and for measurements.

Details of the program may be obtained from Dr. H. van Olphen, National Research Council, National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418 or Dr. Howard J. White, Jr., Office of Standard Reference Data, National Bureau of Standards, Washington, D.C. 20234.

CCST NEWS *continued*

and use; and guidelines for the use of existing standards as well as need for the creation of new ones.

The Workshop was designed to permit as much people interaction as possible by employing both man-to-man and man-to-machine conversation. All conference rooms were equipped with time-shared display terminals for recording the proceedings, including all important conclusions, in real time. The major topics discussed in the various workshops were the ASCII code assignment for terminal controls, sign-on protocols, "handshaking" and common terminology, cable TV requirements and future use, hardware and circuit configurations, types of interfaces, and the characteristics of terminals as viewed from the computer.

The tutorial lectures covered the role of standards in teleprocessing and interactive cable TV, ASCII code applications and their extension for use with display terminals, state of the art and associated problems, and the computer's view of terminal characteristics.

A panel discussion on the "State of Interactive Cable TV" included discussions of the head-end (the distribution center) of a cable TV network, the cable distribution (head-end to terminal) network, interactive cable TV systems, equipment configurations, and field trials in the home or user's environment.

The ASCII workshop emphasized the need for greater cooperation among the groups preparing the associated standards for signalling speeds and line control. It also saw the need for prompt development and acceptance of a character and control set for display terminals, such as the one developed at the Soft Copy Conference held at NBS in 1970.

The workshop on "Characteristics of Terminals as Viewed from the Computer" defined three categories in the functional and physical (hardware) areas: (1) non-sophisticated terminals with little or no built-in logic, (2) disciplined terminals with built-in, fixed logic operations, and (3) intelligent terminals that are programmed and have substantial hardware logic. The group recommended that immediate action be taken to develop a dictionary or glossary, to catalog terminal characteristics, and to develop a classification scheme that would enable the computer to identify terminal characteristics for ease in communication and control.

The workshop on interfacing felt that the parameters used in the EIA RS-232 standard, Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange, as well as the current low-speed modem practices, were adequate for the cable TV environment. They concluded that "frame snatching," polling, and other related digital techniques should be used.

The luncheon speaker, E. J. Istvan, Consultant to the Director of the Center for Computer Sciences and Technology, discussed the role of the computer and the consumer. The interaction at the interface between the two presents an area which requires a clear definition of the services each needs in order to perform his task. He pointed out that while the technology for interaction between individuals and large data bases or services exists, the demand for use by the individual in his own dwelling has not yet been exploited.

Other discussions ranged from political involvement to the economics and design of the hardware. Psychological problems, engineering requirements in the communications and terminal areas, educational use, and the interaction between cable TV and computer utilities were also noted. The group did not come to a firm consensus on any of the topics, but did feel that further definition of the interaction among the various fields was needed to make the problems visible.

The proceedings, including transcripts of the lectures and panel discussions, will be published by the Society for Information Display. Information concerning the availability of the proceedings will appear in a future issue of the CCST NEWS.

RADIATION NEWS *continued*

IMMEDIATE FUTURE ACTION

The second Council meeting, in May, will face the task of reviewing and compiling all of the requests for specific measurements by the various Working Groups into a comprehensive list organized according to priority. Assignment of priorities will be based on the detailed justification assembled along with the measurement requests. The work of this second Council meeting will then form the basis for a detailed discussion with the NBS. By late summer, the Bureau and the Council plan to review alternatives for achieving the measurement capability contained in the consensus developed by the Council.

The Council then intends to submit detailed requests to NBS for the development of specific measurement capability and to outline a program that it can carry out independently of, and in cooperation with, NBS.

The monitoring of active progress toward the goals defined will constitute an important part of the Council program throughout the coming year. A series of topical meetings is envisioned to facilitate technical communications among those facing problems in this area.

PARTICIPATION

The activity of the Council is open to anyone active either in radiometry or in photometry. Participation in the Council is particularly encouraged for those desiring to develop communication with their colleagues in industry and Government. The second Council meeting will be held May 18 at NBS in Gaithersburg, Md. Information on participation can be obtained from:

Dr. Bruce Steiner
B312 Metrology Building
National Bureau of Standards
Washington, D.C. 20234

PUBLICATIONS of the National Bureau of Standards*

PERIODICALS

Technical News Bulletin, Annual subscription: Domestic, $3; foreign, $4. Single copy price, 30 cents. Available on a 1-, 2-, or 3-year subscription basis. SD Catalog No. C13.13:56.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $9.50; foreign, $11.75. Single copy price varies. SD Catalog No. C13.22/sec.A:74.

Section B. Mathematical Sciences. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25. SD Catalog No. C13.22/sec.B:74.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25. SD Catalog No. C13.22/sec.C:74.

NBS BIBLIOGRAPHIC SUBSCRIPTION SERVICES

Cryogenic Data Center Current Awareness Service (Publications and Reports of Interest in Cryogenics). A literature survey issued weekly. Annual subscription: Domestic, $15; foreign, $20.

Liquefied Natural Gas. A literature survey issued quarterly. Annual subscription: $15.

Superconducting Devices and Materials. A literature survey issued quarterly. Annual subscription: $15.

Send subscription orders and remittances to the Cryogenic Data Center, Room 2022, Cryogenics Building, National Bureau of Standards, Boulder, Colo. 80302.

Electromagnetic Metrology Current Awareness Service (Abstracts of Selected Articles on Measurement Techniques and Standards of Electromagnetic Quantities from D-C to Millimeter-Wave Frequencies). Issued monthly. Annual subscription: $100 (special rates for multi-subscriptions). Send subscription order and remittance to the Electromagnetic Metrology Information Center, Electromagnetics Division, National Bureau of Standards, Boulder, Colo. 80302.

OTHER NBS PUBLICATIONS

Baker, M. A., Three-year inspection of nature-tone porcelain enamels on steel, Nat. Bur. Stand. (U.S.), Tech. Note 707, 16 pages (Dec. 1971) 30 cents, SD Catalog No. C13.46:707.

Blaine, R. L., Arni, H. T., Interrelations between cement and concrete properties, Part 5, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 35, 129 pages (Nov. 1971) $1.25, SD Catalog No. C13.29/2:35.

Breden, L. H., Editor, World index of plastics standards, Nat. Bur. Stand. (U.S.), Spec. Publ. 352, 458 pages (Dec. 1971) $5.50, SD Catalog No. C13.10:352.

Bullis, W. M., Editor, Methods of measurement for semiconductor materials, process control, and devices, Quarterly Report—April 1 to June 30, 1971, Nat. Bur. Stand. (U.S.), Tech. Note 702, 45 pages (Dec. 1971) 50 cents, SD Catalog No. C13.46:702.

Chumas, S. J., Tabulation of voluntary national standards, industry standards, international recommendations and certification programs for consumer products, Nat. Bur. Stand. (U.S.), Tech. Note 705, 74 pages (Dec. 1971) 70 cents, SD Catalog No. C13.46:705.

Clark, S. K., Editor, Mechanics of pneumatic tires, Nat. Bur. Stand. (U.S.), Monogr. 122, 853 pages (Nov. 1971) $4.75, SD Catalog No. C13.44:122.

Corliss, Edith L. R., Facts about hearing and hearing aids, Nat. Bur. Stand. (U.S.), Consum. Inf. Ser. 4, 31 pages (Nov. 1971) 60 cents, Stock Number 0303-0920.

Devereux, C. W., II, Technical Standards Coordinator, Body measurements for the sizing of boys' apparel, Nat. Bur. Stand. (U.S.), Prod. Stand. 36-70, 24 pages (Dec. 1971) 35 cents, SD Catalog No. C13.20/2:36-70.

Eisele, J. W., Technical Standards Coordinator, Flame-resistant paper and paperboard, Nat. Bur. Stand. (U.S.), Prod. Stand. 46-71, 10 pages (Oct. 1971) 10 cents, SD Catalog No. C13.20/2:46-71.

Fickett, F. R., Martensite transformation detection in cryogenic steels (magnetometer development), Nat. Bur. Stand. (U.S.), Tech. Note 613, 31 pages (Dec. 1971) 40 cents, SD Catalog No. C13.46:613.

Glass, A. J., Guenther, A. H., Damage in laser materials: 1971, Nat. Bur. Stand. (U.S.), Spec. Publ. 356, 174 pages (Nov. 1971) $1.50, SD Catalog No. C13.10:356.

Hammond, H. K., III, Mason, H. L., Editors, Precision measurement and calibration, Selected NBS papers on radiometry and photometry, Nat. Bur. Stand. (U.S.), Spec. Publ. 300, Vol. 7, 685 pages (Nov. 1971) $7, SD Catalog No. C13.10:300/v.7.

Hogben, D., Peavy, S. T., Varner, R. N., OMNITAB II—User's reference manual, Nat. Bur. Stand. (U.S.), Tech. Note 552, 264 pages (Oct. 1971) $2, Stock Number 0303-0918.

Kusuda, T., Editor, Use of computers for environmental engineering related to buildings, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 39, 826 pages (Sept. 1971) $7.75, SD Catalog No. C13.29/2:39.

Lee, T. G., Interlaboratory evaluation of smoke density chamber, Nat. Bur. Stand. (U.S.), Tech. Note 708, 80 pages (Dec. 1971) 75 cents, SD Catalog No. C13.46:708.

Lew, H. S., Leyendecker, E. V., Dikkers, R. D., Engineering aspects of the 1971 San Fernando earthquake, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 40, 419 pages (Dec. 1971) $3, SD Catalog No. C13.29/40.

Marsden, C. P., Tabulation of data on semiconductor amplifiers and oscillators at microwave frequencies, Nat. Bur. Stand. (U.S.), Tech. Note 597, 48 pages (Dec. 1971) 50 cents, SD Catalog No. C13.46:597.

Menis, O., Shultz, J. I., Editors, Analytical Coordination Chemistry Section: Summary of activities July 1970 to June 1971, Nat. Bur. Stand. (U.S.), Tech. Note 584, 175 pages (Dec. 1971) $1.50, SD Catalog No. C13.46:584.

Parker, V. B., Wagman, D. D., Evans, W. H., Selected values of chemical thermodynamic properties—Tables for the alkaline earth elements (Elements 92 through 97 in the standard order of arrangement), Nat. Bur. Stand. (U.S.), Tech. Note 270-6, 119 pages (Nov. 1971) $1.25, SD Catalog No. C13.46:270-6.

Persson, K-B, Johnson, E. G., Jr., The errors in plasma measurements by the microwave cavity techniques, Nat. Bur. Stand. (U.S.), Tech. Note 607, 64 pages (Oct. 1971) 65 cents, SD Catalog No. C13.46:607.

Sappenfield, K. M., Marinenko, G., Hague, J. L., Standard Reference Materials: Comparison of redox standards, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-24, 97 pages (Jan. 1972) $1, SD Catalog No. C13.10:260-24.

Schafft, H. A., Wire-bond electrical connections: Testing, fabrication and degradation—A bibliography 1957-1971, Nat. Bur. Stand. (U.S.), Tech. Note 593, 58 pages (Jan. 1972) 60 cents, SD Catalog No. C13.46:593.

Taylor, J. K., Editor, Microchemical Analysis Section: Summary of Activities, July 1970 to June 1971, Nat. Bur. Stand. (U.S.), Tech. Note 585, 77 pages (Jan. 1972) 70 cents, SD Catalog No. C13.46:585.

Viezbicke, P. P., NBS frequency-time broadcast station WWV, Fort Collins, Colo., Nat. Bur. Stand. (U.S.), Tech. Note 611, 29 pages (Oct. 1971) 35 cents, SD Catalog No. C13.46:611.

White, H. S., Jr., Standards Coordinator, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub.) 19, 7 pages (1971) 20 cents, SD Catalog No. C13.52:19.

Wollin, H. F., Compiler and Editor, National Bureau of Standards Handbook 44—4th Edition—1971, Specifications, Tolerances, and other technical requirements for commercial weighing and measuring devices, Superseding Handbook 44—3rd Edition, Nat. Bur. Stand. (U.S.), Handb. 44—4th Edition, 207 pages (1971) $2, SD Catalog No. C13.11:44/4.

PUBLICATIONS IN OTHER JOURNALS

This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.

Wasik, S. P., Tsang, W., Determination of trace amounts of contaminants in water by isotope dilution gas chromatography, Anal. Chem. 42, No. 13, 1649–1651 (November 1970).

Wasik, S. P., Tsang, W., Gas-liquid chromatography separations of hydrocarbons using columns with aqueous solutions of complexing metal ions as stationary phases, Anal. Chem. 42, No. 13, 1648–1649 (November 1970).

Waxman, M., Hastings, J. R., Chen, W. T., Nonlinear statistical analysis of Burnett PVT data, Proc. 5th Symp. on Thermophysical Properties, Boston, Mass., September 30–October 2, 1970, C. F. Bonilla, Ed., pp. 248–261 (American Society of Mechanical Engineers, New York, N.Y., 1970).

Weir, C. E., Block, S., Piermarini, G. J., Compressibility of inorganic azides, J. Chem. Phys. 53, No. 1, 4265–4269 (December 1970).

Yokel, F. Y., Somes, N. F., Proposed revision of ACI 318-63 Building Code Requirements for Reinforced Concrete, J. Am. Concrete Inst. **67**, No. 9, 723–725 (Sept. 1970).

Young, J. P., Lamb, V. A., Reid, G. I., Berkeley, J. F., Ng, W., Electroplated coatings on maraging steel for retarding catalytic decomposition of hydrazine rocket fuel, Plating **57**, No. 9, 921–926 (Sept. 1970).

Younglove, B. A., Straty, G. C., A capacitor for accurate wide range dielectric constant measurements on compressed fluids, Rev. Sci. Instr. **41**, No. 7, 1087–1089 (July 1970).

Younglove, B. A., Measurements of the dielectric constant of saturated liquid oxygen (Proc. 1969 Cryogenic Engineering Conf., June 16–18, 1969, Univ. of California, Los Angeles), Chapter in Advances in Cryogenic Engineering 15, Paper No. C-3, 70–75 (Plenum Press, Inc., New York, N.Y., 1970).

**Publications with prices and SD Catalog numbers indicated may be purchased directly from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (foreign: one-fourth additional). NBS nonperiodical series are also available from the National Technical Information Service (NTIS), Springfield, Va. 22151 (formerly the Clearinghouse for Federal Scientific and Technical Information). Reprints from outside journals and the NBS Journal of Research may often be obtained directly from the authors.*